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METHOD OF TREATING FABRICATED TUNGSTEN WIRES OR RODS

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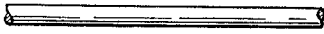


Fig. 1



Fig. 2



Fig. 3

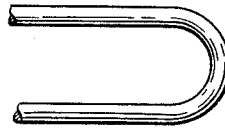


Fig. 4

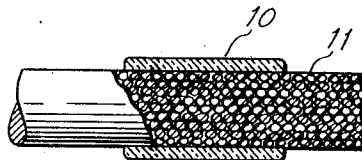


Fig. 5

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METHOD OF TREATING FABRICATED
TUNGSTEN WIRES OR RODS

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7 Claims. (Cl. 148—13.1)

My invention relates to a method of treating fabricated tungsten wires or rods to improve their grain structure and is a continuation in part of my copending application, Serial No. 295,259 filed September 16, 1939, which has matured into Patent No. 2,258,992. It also relates to a method of treating fabricated ductile tungsten wires or rods to provide lead-in wires or electrodes having an improved grain structure.

In the usual method of preparing fabricated ductile tungsten wires or rods, tungsten oxide in a substantially pure state is reduced in an atmosphere of hydrogen or by the carbon reduction process, pressed into ingots and after presintering to permit handling, is heated by an electrical current to a temperature somewhat below its melting point to render it coherent. The tungsten metal as thus produced is fabricated into the form of ductile wires or rods by working when hot, such as by drawing or swaging, and it is to be understood that when the term "fabricated ductile tungsten" is used in the specification and claims it refers to tungsten which has been heated to a sufficiently high temperature to render it coherent and which has been fabricated sufficiently as by forging, drawing or swaging when hot to render it ductile.

Fabricated ductile tungsten wires or rods formed in such manner have been utilized extensively as lead-in wires for tubes, such as radio tubes or as electrodes in atomic hydrogen welding and in gas-filled tubes employed in advertising or display purposes. Such wires or rods, however, have a laminated grain structure, the longitudinal grain boundaries of which have the tendency to develop into cracks when stress is applied. Consequently, when the wire or rod is utilized as lead-in wires or electrodes in evacuated tubes or those containing a gas, such as neon, air has the tendency to leak or diffuse into the tube between the laminations and destroys or adversely affects the efficiency of the tube. When ductile tungsten wires or rods are utilized as electrodes for atomic hydrogen welding, they are inherently flexible and bend during handling and consequently are not as desirable for maintaining a constant space between the arc ends of the electrodes as straight nonbend rods.

It is the aim of the present invention to provide an improved method of treating fabricated ductile wires or rods to improve their grain structure.

Another object of my invention is to provide an improved process of preparing nonbend rods having an improved grain structure.

A further object of my invention is to provide an improved process of producing rods or wires from fabricated ductile tungsten having a dispersed grain structure in which the tungsten grains are not substantially larger than those in fabricated ductile tungsten.

A still further object of my invention is to provide an improved process of producing electrodes having an improved grain structure from fabricated ductile tungsten.

My invention will be better understood by reference to the accompanying drawing in which:

Fig. 1 is a fabricated ductile tungsten rod formed by a drawing or swaging operation;

Fig. 2 is partially an elevational and partially a cross sectional view of the rod shown in Fig. 1 on an enlarged scale, the cross sectional portion showing diagrammatically the laminated grain structure of the tungsten;

Fig. 3 is a view similar to Fig. 2, showing diagrammatically the grain structure of the tungsten after my improved treating process;

Fig. 4 is an elevational view of a nonbend wire or rod which has been treated by my improved process; and

Fig. 5 is an enlarged view partially in cross section of a tungsten rod and a glass bead formed thereon, showing the grain structure of the tungsten after my improved treating process.

According to my invention, the tungsten rod is fabricated in the usual manner, that is by heating the reduced and presintered metal to a temperature slightly below its melting point to prepare an ingot which is worked into the form of a rod or wire by forging, drawing or swaging, as shown in Fig. 1 in which the laminated grain structure runs longitudinally with the rod as shown diagrammatically in Fig. 2. However, if desired, a wire or rod formed of the tungsten metal may be bent into any desired form as shown in Fig. 4 of the drawing. In such cases, however, the diameter of the rod must not exceed .093 of an inch as tungsten rods having a larger diameter cannot be bent.

The rods or wires, thus formed, are placed in a container which is capable of resisting the heat required, such as a container formed of tungsten or molybdenum, and are heated to a temperature of 900° to 1600° C. in a nonoxidizing atmosphere, such as hydrogen, although other nonoxidizing or inert gases may be employed, such as nitrogen, a mixture of hydrogen and nitrogen, ammonia or the like. As a result of this treatment the grain structure of the tungsten is dispersed as shown in Fig. 3 without substantially increasing the

size of the grains and the tungsten loses its ductility. When a shaped electrode or a non-bend rod or wire is desired, it is necessary to bend the metal prior to heat treatment because the tungsten loses its ductility during the heat treatment and cannot be permanently bent. The term "nonbend" rod or wire when used in the specification and claims is intended to define a wire or rod which cannot be permanently deformed without breaking.

In forming my improved electrode it is important that the temperature shall not exceed 1600° C. because when the rod is heated above 1600° C. the tungsten grains increase in size which causes the metal to become brittle.

To form an electrode for tubes or the like, a glass bead 10 may be formed upon the rod 11 which is then inserted as a lead-in wire in the tube, the glass of the tube being fused to the beading in the usual manner.

The time of treatment is of course dependent upon the temperature and the thickness of the wire or rod and generally ranges from about ten to forty minutes, a longer time being required for wires or rods having larger diameters or when the temperature is low. The treatment should be continued, however, until the metal loses its ductility and the grain structure is uniformly dispersed and in order to obtain dispersion of the metal without causing increased grain size, the temperature should preferably be maintained below 1400° C. and must be maintained below 1600° C. which is considerably lower than the temperature normally existing in the filaments of incandescent lamps.

In treating ordinary electrodes for vacuum or gas-filled tubes, I preferably treat the wire at a temperature of 1230° to 1260° C. for a period of approximately fifteen minutes. Rods or electrodes treated by my improved process will not split and consequently leakage or fusion of air or gases through the rod or electrode is eliminated.

What I claim is:

1. The method of treating fabricated ductile tungsten wires or rods which comprises heating a tungsten wire or rod in its fabricated ductile state at a temperature of 900° to 1400° C. in a nonoxidizing atmosphere for sufficient time to cause sufficient dispersion of the grain structure of the tungsten to render it nonductile and to provide a substantially uniformly dispersed tungsten grain structure in which the tungsten grains are not substantially larger than in standard ductile tungsten.

2. The method of treating fabricated ductile tungsten rods or wires which comprises heating the tungsten wire or rod in its fabricated ductile state at a temperature of 1200° to 1400° C. in a nonoxidizing atmosphere for sufficient time to cause sufficient dispersion in the grain structure of the tungsten to render it nonductile and to provide a substantially uniformly dispersed tungsten grain structure in which the tungsten grains are not substantially larger than in standard ductile tungsten.

3. The method of forming lead-in wires or electrodes which comprises heating a ductile

tungsten rod in its fabricated ductile state at a temperature of 900° to 1400° C. in a nonoxidizing atmosphere for sufficient time to cause sufficient dispersion of the grain structure of the tungsten to render it nonductile and to provide a substantially uniformly dispersed tungsten grain structure throughout the length of the wire or electrode in which the tungsten grains are not substantially larger than in standard ductile tungsten.

4. The method of forming nonbend wires or rods which comprises bending a fabricated ductile tungsten wire or rod into the desired shape and heating it at a temperature of 900° to 1400° C. in a nonoxidizing atmosphere for sufficient time to cause sufficient dispersion in the grain structure of the tungsten to render it nonductile and to provide a substantially uniformly dispersed tungsten grain structure throughout the length of the wire or rod in which the tungsten grains are not substantially larger than in standard ductile tungsten.

5. The method of forming nonbend rods which comprises bending a fabricated ductile tungsten rod into the desired shape and heating it at a temperature of 1200° to 1400° C. in a nonoxidizing atmosphere for sufficient time to cause sufficient dispersion of the grain structure of the tungsten to render it nonductile and to provide a substantially uniformly dispersed tungsten grain structure throughout the length of the wire or rod in which the tungsten grains are not substantially larger than in standard ductile tungsten.

6. The method of treating fabricated ductile tungsten wires or rods which comprises heating a tungsten wire or rod in its fabricated ductile state at a temperature of 900° to 1400° C. in a nonoxidizing atmosphere for sufficient time to cause sufficient dispersion of the grain structure of the tungsten to render it nonductile and to provide a substantially uniformly dispersed grain structure of the tungsten throughout the length of the wire or rod in which the size of the tungsten grains is not substantially larger than in standard ductile tungsten, a sufficient time of treatment being dependent upon the temperature and the thickness of the wire or rod and being of the order of approximately ten to forty minutes.

7. The method of forming nonbend wires or rods which comprises bending a fabricated ductile tungsten wire or rod into the desired shape and heating it at a temperature of 900° to 1400° C. in a nonoxidizing atmosphere for sufficient time to cause sufficient dispersion in the grain structure of the tungsten to render it nonductile and to provide a substantially uniformly dispersed grain structure of the tungsten throughout the length of the wire or rod in which the size of the tungsten grains is not substantially larger than in standard ductile tungsten, a sufficient time of treatment being dependent upon the temperature and thickness of the wire or rod and being of the order of approximately ten to forty minutes.

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